Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/176
UNITED KINGDOM
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

PHYSICS PROBLEMS OF WATER REACTORS MODERATED BY A VARIABLE D_2O/H_2O MIXTURE

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Changes in reactivity resulting from burnup of a reactor core can be controlled by the method of variable moderation, using changing mixtures of D_2O and H_2O. This paper reports the physics investigations made in a study of small reactors operating on the pressurised water principle in which the application to marine propulsion has received some special attention. The description centres round the experimental core of 40 MW nominal heat output which is to be installed for test purposes in the BR3 reactor at Mol, Belgium.

The requirements imposed on the core design were that (i) it should have a long operating life, (ii) the parameters of the experimental core should be chosen so that in a power reactor core of the same basic design the shut-off rod capacity would be sufficient to maintain subcriticality even if the reactor were flooded with cold light water at the start of life, (iii) the temperature coefficient of the moderator/coolant should be sufficient to allow regulation by temperature variations over the load range from zero to full power. The paper describes the principles of the physics design which has been evolved, in which the core is built up of an array of standard size hexagonal units, some of which

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contain fuel and the remainder of which are tubes filled with moderator into which the circular flux-trap type absorber rods are inserted. The methods of calculation for reactivity estimation and burnup, reactivity coefficients, shut-off rod worths and power peaking effects are described. The basis on which the selection of the proportions of moderator to fuel, and coolant to fuel were made are commented on and the relation of power peaking to power output and peak/average burnup discussed. The range of moderator compositions of interest, and the variation with core life is reported.

The core studies have been supported by an initial experimental physics programme at Winfrith, England, and a zero-energy programme at Mol, Belgium, is at present in progress. The two subcritical assemblies and the critical system DIMPLE used in the Winfrith work, and the techniques for the measurement of power peaking, buckling, reaction rates and shut-off rod worths are described and results reported. The analysis of these results by methods developed for the purpose is given and a comparison is made with the design methods used. The VENUS critical assembly at Mol is described and the objects of its programme are given.

Finally a brief description is given of the measurements it is intended to carry out in the BR3 experiment to obtain nuclear and thermal data to aid future designs.